

CLAIMS:

1. A magnetic storage medium comprising:
a substrate having a substrate surface;
a seedlayer structure overlying the substrate surface; and
5 a magnetic material layer on the seedlayer structure, the magnetic material layer having a C-axis tilted at about a first angle with respect to an axis perpendicular to the substrate surface and having a magnetic easy axis oriented at a second angle with respect to the axis perpendicular to the
10 substrate surface.
2. The magnetic storage medium of claim 1 wherein the seedlayer structure includes crystallographic texture tilted with respect to an axis perpendicular to the substrate surface and acts as a template for epitaxial growth.
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3. The magnetic storage medium of claim 1 wherein the first angle is in the range of about 25° to about 55°.
4. The magnetic storage medium of claim 1 wherein the second
20 angle is between about 30° to about 60°.
5. The magnetic storage medium of claim 1 wherein the magnetic material layer is formed of a material with uniaxial anisotropy.
- 25 6. The magnetic storage medium of claim 1 wherein the magnetic material layer is formed of a material with coercivity greater than 2000 Oe.
7. The magnetic storage medium of claim 6 wherein the magnetic material layer is formed of a Co alloy.

8. The magnetic storage medium of claim 1 wherein the seedlayer structure comprises:
- 5 a first seedlayer that defines a tilted grain structure; and
a second seedlayer overlying the first seedlayer that creates a preferred crystallographic texture and provides a template for epitaxial growth of the magnetic material layer.
- 10 9. The magnetic storage medium of claim 8 wherein the first seedlayer is formed from Ta.
10. The magnetic storage medium of claim 8 wherein the second seedlayer is formed from Ru.
- 15 11. The magnetic storage medium of claim 8 wherein the magnetic material layer is formed from a Co alloy.
12. The magnetic storage medium of claim 1 and further comprising:
20 a soft magnetic underlayer between the substrate and the seedlayer structure.
13. The magnetic storage medium of claim 1 wherein the magnetic material layer has a columnar structure oriented generally perpendicular to the substrate surface.
- 25 14. The magnetic storage medium of claim 1 wherein the magnetic material layer has a columnar structure oriented generally tilted relative to the substrate surface.

15. The magnetic storage medium of claim 1 wherein the C-axis of the magnetic material layer is organized with azimuthal symmetry.
16. The magnetic storage medium of claim 1 wherein the C-axis of
5 the magnetic material layer is organized into a radial pattern.
17. The magnetic storage medium of claim 1 wherein the C-axis of the magnetic material layer is organized into a circumferential pattern.
- 10 18. A rigid thin film magnetic medium for use in a data storage device having a surface normal, the thin film magnetic storage medium comprising:
a substrate; and
a magnetic material layer, the magnetic material layer
15 comprising:
a C-axis; and
a uniaxial magnetic easy axis tilted with respect to surface normal.
- 20 19. The rigid thin film magnetic medium of claim 18 wherein the magnetic material layer has a perpendicular grain structure.
20. The rigid thin film magnetic medium of claim 18 wherein the magnetic material layer has a tilted grain structure.
- 25 21. The rigid thin film magnetic medium of claim 18 wherein the magnetic easy axis is organized with azimuthal symmetry.

22. The magnetic storage medium of claim 18 wherein the magnetic easy axis is organized with a radial pattern.
23. The magnetic storage medium of claim 18 wherein the magnetic material layer is organized with a circumferential pattern.
24. The rigid thin film magnetic storage medium of claim 18 wherein the C-axis is tilted between about 25° and about 55° and the magnetic easy axis is tilted between about 30° and about 60° with respect to surface normal.
25. The rigid thin film magnetic storage medium of claim 18 further comprises a seedlayer structure underlying the magnetic material layer.
26. The rigid thin film magnetic storage medium of claim 25 wherein the magnetic material layer is grown with epitaxy on the seedlayer structure.
27. The rigid thin film magnetic storage medium of claim 25 wherein the seedlayer structure further comprises:
- a first seedlayer overlying the substrate that defines a tilted columnar structure; and
 - a second seedlayer overlying the first seedlayer that defines a tilted crystalline structure and provides a template for epitaxial growth of the magnetic material layer.
28. The rigid thin film magnetic storage medium of claim 27 wherein the first seedlayer is Ta.
29. The magnetic storage medium of claim 27 wherein the second seedlayer is Ru.

30. The magnetic storage medium of claim 27 wherein the magnetic thin film is CoPtCr.
- 5 31. The magnetic storage medium of claim 27 and further comprising a soft magnetic underlayer between the substrate and the seedlayer structure.
32. A method of forming a magnetic storage medium having tilted magnetic anisotropy relative to surface normal, the method comprising:
- 10 depositing a seedlayer structure over a surface in a collimated manner at a deposition angle of incidence of greater than 45° with respect to surface normal; and
- depositing a magnetic material with a C-axis over the seedlayer structure to epitaxially grow a magnetic material layer
- 15 having a magnetic easy axis tilted with respect to surface normal.
33. The method of claim 32 wherein the magnetic easy axis is tilted at an angle of between about 30° and about 60° with respect to surface normal.
- 20 34. The method of claim 32 wherein depositing the magnetic material occurs by non-oblique deposition.
34. The method of claim 31 wherein depositing the magnetic
- 25 material occurs by oblique deposition.
35. The method of claim 31 wherein depositing the seedlayer structure comprises:

depositing a first seedlayer that defines a tilted columnar structure; and

depositing a second seedlayer overlying the first seedlayer wherein the second seedlayer provides a template for epitaxial growth of the magnetic material layer.

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36. The method of claim 35 wherein the first seedlayer is Ta.

37. The method of claim 35 wherein the second seedlayer is Ru.

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38. The method of claim 35 wherein the magnetic material layer is a Co alloy.

39. The method of claim 35 wherein the magnetic material layer has a grain structure in which grains are oriented generally parallel to the surface normal.

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40. The method of claim 35 wherein the magnetic material layer has a grain structure in which grains are generally tilted relative to the surface normal.

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